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DISTANCE LEARNING: PART OF THE NATIONAL PERFORMANCE REVIEW INITIATIVE ON EDUCATION

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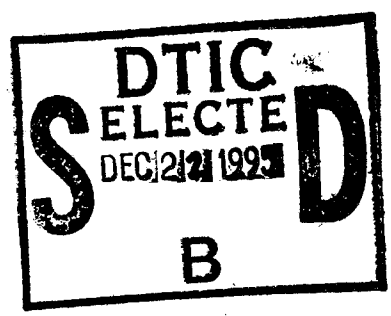

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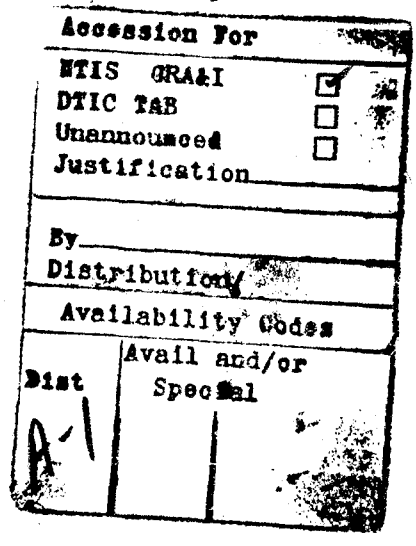
PREFACE

This paper has been prepared as part of a Central Research Project on the National Information Infrastructure (NII). The objective of the paper was to enhance IDA's understanding of the activities, organizations, and issues related to the implementation of Distance Learning as part of the NII. With an increased understanding of this issue in particular, and the NII in general, IDA will be in a position to support a sponsor on tasking related to the NII.

Information presented in this paper was derived from reports issued by the Information Infrastructure Task Force (IITF), which are listed in Appendix B, minutes of various IITF committee meetings, Armed Forces Communications and Electronics Association sponsored symposiums, and personal meetings with various government representatives.

The authors thank Mr. Edward Kerlin and Mr. Willard (Chris) Christenson for their careful and thorough review of this document.



CONTENTS

APPENDICES

I. INTRODUCTION

A. BACKGROUND

In his technology progress report for economic growth, delivered on February 22, 1993, President Clinton said, "Facilitating the development of a National Information Infrastructure (NII) is a top Administration priority, a necessity for economic growth in the 21st century." Essential ingredients to this initiative are the technologies to create, manipulate, manage, and use information, which is one of the nation's more critical economic resources. The development and employment of these emerging information technologies will form the core of the National Information Infrastructure.

In September 1993 the White House formed the Information Infrastructure Task Force (IITF) to articulate and implement the Clinton administration's vision for the National Information Infrastructure. In May 1994, the Task Force released a report entitled *Putting the Information Infrastructure to Work.* This report is a collection of papers describing how the evolution of the NII can impact seven key areas of interest as defined by the IITF's Committee on Applications & Technology. These seven initial areas were chosen because of their significant, and in some cases immediate, impact on the public through the application of advanced information and communications technologies. One of these seven areas of interest is quality education and lifelong learning for all Americans.

The NII will be the vehicle for improving education and for providing lifelong learning, as well as employee training, throughout America. Through the NII, students of all ages will use multimedia electronic libraries and museums containing text, images, video, music, simulations, and instructional software. The NII will give teachers, students, employers, and instructors access to a great variety of instructional resources and to each other.

Successful implementation of the NII to serve the nation's education and lifelong learning needs will require significant contributions by the private sector, state and local governments, the federal government, and the non-profit sector. The possible contributions and roles of these three sectors are briefly discussed below.

- The private sector's role in providing telecommunications services and applications for education and lifelong learning has been expanding rapidly in recent years, and should continue to do so. The private sector will build the telecommunications infrastructure and must make substantial investments in applications development for education and lifelong learning.

- State and local governments provide over 90 percent of the nation's investment in elementary and secondary education and provide a large percentage of the investment in higher education. Accordingly, they must continue this level of spending for expanding information technology capability throughout the nation's elementary and secondary education infrastructure. In addition, states are in the position to remove regulatory and tariff barriers to NII access in the local communities.

- The federal government has three principal responsibilities. It facilitates the private sector investment in infrastructure and applications for education and lifelong learning by creating incentives; removing regulatory barriers; establishing standards; supporting research, evaluation, and prototype development; developing visionary benchmark applications; and providing assistance to the education and training communities. It communicates a vision for the education, training, and lifelong learning uses of the NII. And, most importantly, the federal government must promote access for all citizens to the resources of the NII.

A key enabling service that will support the education initiative will be digital libraries—also one of the seven initial areas of interest that the administration is considering for development through the application of advanced information technology. Digital libraries will provide the ability to create information resources that allow access to electronic documents. Access to publications in digital format via the NII supports the goal of the Clinton administration of providing education on a lifelong basis.

The initiative to improve education and provide citizens with the capability of lifelong learning commits the government to promote the use of advanced information technology as a tool to develop a quality educational process. Part of the education initiative involves establishing an infrastructure that supports distance learning, which is the focus of this paper.

B. DISTANCE LEARNING

Distance learning is a general term used to cover the broad range of teaching and learning events in which the student is separated from the instructor, or other students, by distance and/or time.[1] It includes such scenarios as computers in the classroom or workplace, local area networks on a college campus, remote training, and access to educational opportunities from the home.

Through the implementation of the NII, distance learning can take the very simple form of home computer access to an on-line educational service, or the highly complex form of interactive multimedia and videoconferencing. Interactive, high performance uses of technology, such as networked teams collaborating to solve real-world problems, retrieving information from electronic libraries, and performing scientific experiments in simulated environments, are indeed the ambitious goals of distance learning that can be achieved through the development and implementation of the NII.

By employing advanced information and telecommunications technologies, organizations can provide new and enriched training scenarios. The applicability of these new technologies for distance learning will most likely depend on where the learner is located—at home, in workplace training, or at a training center. In general, the home office has the fewest assets, especially advanced information technology assets, while a centralized training center can provide very powerful multimedia and telecommunications equipment. The work place training environment is equipped somewhere in between.

When organizations are developing remote training programs, they must consider where the training will be located and the type of telecommunications and computer assets that will be available. Also, the training developers need to keep in mind that some technological or telecommunications configurations provide more effective solutions to a certain training problem than others.

From the Department of Defense perspective, distance learning or remote training refers to any type of training that occurs through a distributive environment. For instance, providing training from a central hub location to military members at various permanent duty stations at the same time constitutes remote training.

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[1] Throughout this paper the terms *distance learning*, *distance education*, and *remote training* are used interchangeably.

A prime example of remote training is the dual simulation training program for selected units of the US Army National Guard. This program is supported by a distributed software training system that was developed by the Institute for Defense Analyses using the Janus computer model. Janus is a combat simulation with a long history of applications in the field of training and analysis.

II. GOALS AND OBJECTIVES OF DISTANCE LEARNING

A. THE NATIONAL PERFORMANCE REVIEW

The National Performance Review (NPR) was created in March 1993 when President Clinton requested that Vice President Gore lead an intensive, 6-month study of the federal government. In September 1993 the NPR released its report. One element that the NPR focused on was the utilization of advanced information technology to improve such areas as health care, government services, and education.

The NPR envisions that the NII can take students, workers, teachers, and private citizens beyond the limits of traditional learning environments, offering them greater access to a variety of instructional materials from a wealth of sources. The NII will provide access to a great variety of instructional resources and will allow students access to their peers throughout the country. It will give educators and managers new tools for improving the operations and productivity of their institutions. Workplaces will become lifelong learning environments, supporting larger numbers of high skill, high wage jobs.

One key advantage of integrating information technology in schools may be the opportunity for innovation. With schools and universities increasingly connected through the NII, teachers will be able to use computers in new and creative ways. *When* [computers are] *properly integrated into the classroom, students become active learners instead of passive sitters, test takers, and clock watchers. They are inspired to excel and to become involved with the learning process, not only for today, but for life.*[1]

Of course, these benefits depend upon several factors, including the instructional methods used, the quality of the applications, the availability of professional development for educators, the accessibility of instructional materials, and the presence of a technical support staff. Several state-sponsored prototype programs, in after-action reports, have cited the importance of having good technical support available to the schools. These

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1 *Putting the Information Infrastructure to Work,* report released by the IITF Committee on Applications & Technology, May 1994.

same reports have highlighted the importance of institutionalizing this training process, through implementation and practice, in order to fully achieve the benefits of advanced information technology.

B. DEPARTMENT OF DEFENSE

The Department of Defense is focusing on new ways to train and maintain readiness in the face of reduced defense budgets. Two areas of concentration are the use of distributed modeling and simulation (M&S), and the use of distributed networking to provide the traditional schoolhouse training. Both techniques increasingly rely on advanced information technology and broadband networks to provide training to military members at their permanent duty stations instead of at a centralized training center.

When implementing a distributed training environment the DoD should keep in mind that participants working at their permanent duty stations may be easily distracted from training exercises by their daily work routine. Also, it is obvious that some unit training objectives can be accomplished only through troop deployment exercises. In the end, the customers' (or users') needs and requirements will influence the feasibility of using a distributed training process. However, as deployment costs rise and information technology improves, the military is expected to increase its use of distributed training techniques.

The Department of Defense is developing and implementing a network to support distributed interactive simulation (DIS). This technology, which allows dispersed learners to engage in collaborative problem-solving activities in real time, is now ready for use by schools and workplaces outside of the defense sector.

The Department of Defense is involved in providing lifelong education and training to hundreds of thousands of military personnel. It also supports Research and Development (R&D) for education and training and is expected to transfer knowledge and software to schools and non-Defense workplaces under its Dual-Use and Technology Reinvestment programs. The Department of Defense Dependent School System is expected to serve as a testbed for new applications.

The Department of Defense is also conducting pilot programs and advanced technology demonstrations in the area of providing distance learning, or remote training, to the military forces. These initiatives are being explored from the perspective of reducing training costs by providing training on a decentralized basis instead of a centralized basis. The standard training programs of the past have assembled military

personnel in a central school location for training, or instruction, on a particular curriculum. This training format, besides being very costly, caused military participants to be away from their permanent duty stations for an extended period of time.

The DoD is also actively involved in developing information technology standards. To achieve standardization the Department of Defense has a strategy that entails championing DoD's requirements in commercial standards, utilizing to the maximum extent possible standards-based commercial off-the-shelf (COTS) products, and developing guidance for the military services that is based on commercial standards.

III. ORGANIZATIONAL ACTIVITIES

The creation of an advanced information infrastructure that can support an educational environment on a national basis, as proposed by the National Performance Review (NPR), requires solutions to many technical, legal, security, financial, and regulatory barriers. Also, widespread adoption and use of a variety of technical standards for communications, information processing, and security are necessary. To overcome these barriers and to develop and implement standards, numerous organizations have instigated education-related activities. Some of the organizations working on educational issues are described below.

A. DEPARTMENT OF EDUCATION

The Department of Education (DoED) advocates for the needs of all learners in the development of the NII. The Department is the principal source of federal support for distance learning, via the Star Schools Program.[1] The Department also supports applications and programming development, pilot projects, teacher networks, research, and planning grants to states and districts.

The Star Schools Program provides support for distance learning through the funding of telecommunications partnerships. These partnerships include local school districts, state departments of education, public broadcasting entities, and other organizations. Programs produced and offered by grantees include formally structured courses, instructional modules, and video "field trips," and are available in schools in one or more states. Course offerings include hands-on science and mathematics, workplace skills, and six foreign languages. Grantees also offer teacher training programs, parenting seminars, and other services to as many as 500 schools at a time. A variety of telecommunications technologies are being employed to establish one-way and two-way communication. These technologies include satellite communications, cable, fiber optics, microcomputers, digital compression, interactive videodiscs, facsimile machines, and the ordinary telephone.

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1 The Star Schools Program provides quality, cost-effective instruction through distance education. It is funded by grants from the U.S. Department of Education.

The Department of Education has a Gopher[2] server which points to or contains educational research information, such as the AskERIC service and information from sources such as CNN, Academy One, and the Educational Testing Service. AskERIC is a service that enables teachers and other educators to ask questions via electronic mail and have their questions answered by researchers of the Educational Resources Information Center (ERIC) clearinghouses. ERIC is a nationwide network of clearinghouses that produce education databases, prepare over 200 publications each year, and respond annually to approximately 100,000 information requests. ERIC resources are available throughout the world on-line (via the Internet and on many commercial services such as Dialog, America Online, CompuServe, and GTE), as well as in print, CD-ROM and microfiche.

B. DEPARTMENT OF ENERGY

The Department of Energy (DoE) is developing advanced information technologies, such as high performance computing, high speed networking, and high capacity data storage and data bases. The Department is developing computing and communication applications that support new learning techniques and take advantage of the regional presence and capabilities of the Department's laboratories. Emphasis is placed on reaching a broad range of students, including women and underrepresented minorities. Another key technology initiative is the development of digital libraries that will provide users at the various DoE laboratories speedy and economical access to Energy information over an advanced information network.

The National Education Supercomputer (NES) program provides access to a Cray X-MP/18 computer donated to the DoE by Cray Research, Inc. It is located at the National Energy Research Supercomputer Center (NERSC), Lawrence Livermore National Laboratory. The NES is available for on-line use, through dial-up modems, by elementary and high school students and at selected community colleges.

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2 Gopher service is an information access tool that is used over the Internet. It allows a local computer to access different host computers being maintained by other agencies or organizations and to search data bases for information.

C. DEPARTMENT OF COMMERCE

The Department of Commerce provides support and direct funding for telecommunications infrastructure planning and development, and plans to support improvements in workplace training using the NII. The Department's National Institute of Standards and Technology (NIST) supports standards development, which is critical to providing ubiquitous access to the NII.

D. NATIONAL SCIENCE FOUNDATION

In fiscal year 1995 the National Science Foundation (NSF) will support pilot projects to demonstrate applications of intelligent systems in teacher training and lifelong education. The NSF also will develop cross-directorate demonstration projects that explore major efforts to reform interdisciplinary curricula based on technology-enabled science methodology, and will initiate joint agency demonstration projects to provide models for education reform or lifelong learning.

The main NSF activities in support of the education initiative include programs in the Education & Human Resources (EHR) Directorate and the Computer and Information Science and Engineering Directorate (CISE). For EHR, the primary emphases are understanding the costs and benefits of integrating computer networking into the educational infrastructure and developing testbeds and models of network access in support of science and mathematics education at various levels. EHR programs also support research in advanced information and computer technologies for innovation in education. CISE programs focus more on undergraduate and graduate education and research. However, there is increasing emphasis on supporting new research in the development of applications for the general public, as well as for computing sciences, that can be accessed through the NII.

The National Science Foundation also funds the collaborative visualization (CoVis) project. CoVis is a scientific visualization application that uses collaborative hardware and software tools, including desktop videoconferencing. It allows high school students and teachers to study environmental and atmospheric science with their peers and scientists from around the nation. CoVis aims to bring additional knowledge to students as they work on projects related to science, mathematics and technology.

E. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The National Aeronautics and Space Administration (NASA) continues to build on its High Performance Computing and Communications (HPCC) program, its aeronautics and space science research and engineering missions, and its existing education outreach infrastructure to support mathematics, science, and engineering education. This program consists of pilot projects at seven NASA Centers involving many of the local schools and school districts.

F. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

The Department of Housing and Urban Development (HUD) is providing distance learning, policy announcements, and briefings to its staff and to client agencies through satellite downlinks to 55 field offices, as part of the HUD Television Network (HTN). The HTN was implemented in response to a recommendation from the Secretary's Task Force on Departmental Training that technology be used to deliver training and information to HUD staff and client agencies on a nationwide basis. In conjunction with this broadcast capability, HUD has installed a student response keypad system which supports interactive distance learning

This technology gives HUD the ability, on a nationwide basis, to deliver HUD developed training; broadcast information about HUD's programs to a wide audience; and capture satellite broadcasts sponsored by professional organizations, universities and other government entities. With these capabilities HUD can train more staff at lower cost, and more efficiently deliver information about its programs to citizens and HUD's programmatic partners at the local level.

G. DEFENSE INFORMATION SYSTEMS AGENCY

The Defense Information Systems Agency (DISA) is the DoD agency responsible for developing the architecture and strategy for implementing the wideband networks of the Defense Information Infrastructure (DII).[3] These high data rate networks, operating at data rates of 45 Mbps and higher, will provide the bandwidth required to support the various education and training forums that occur throughout the military services on a routine basis.

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[3] The Defense Information Infrastructure is a subset of the National Information Infrastructure.

Besides providing the high bandwidth capacity telecommunications networks, such as the Defense Information Systems Network (DISN), DISA is also actively engaged in developing telecommunications standards. The development and promulgation of standards is critical to ensure interoperability between the numerous operating systems and operating platforms that exist throughout the DoD.

H. ADVANCED RESEARCH PROJECTS AGENCY

The Education and Training Initiative of the Advanced Research Projects Agency (ARPA) is designed to dovetail key DoD needs for training and education with the critical research and technology development required by other national education initiatives. Under this program, selected clusters of community assets, including local military bases, universities, libraries, school districts, and businesses, will be networked with shared assets, such as digital curriculum libraries and educational tools. Several types of tools will be developed so that teachers can take advantage of multimedia, virtual labs, and simulation to obtain critically needed training in technology-related skills. The goal of these pilot programs is to establish an information infrastructure in support of education that will persist beyond the life of these programs.

ARPA is also developing and demonstrating distributed simulations and training programs. The objective of this program, as defined by ARPA, is to double or triple unit training effectiveness compared with that of 1991 through the application of advanced technologies. The simulators and training programs are being developed in concert with the networking and distance delivery attributes of the National Information Infrastructure.

I. INFORMATION INFRASTRUCTURE TASK FORCE

The Information Infrastructure Task Force (IITF) consists of high-level representatives of the federal agencies that play a major role in the development and application of information and telecommunications technologies. It is presently chaired by the the Secretary of Commerce. The primary mission of the IITF is to articulate and implement the Clinton administration's vision for the National Information Infrastructure.

The IITF holds frequent public forums to discuss the issues and areas of interest associated with the NII. These meetings are held to allow the public, private, and government sectors to better understand the issues and barriers pertaining to the

development and implementation of the NII. They also provide a structure for determining how to resolve issues and how to break down barriers. During several of these meetings public school administrators have presented overviews of pilot programs being conducted in their school districts that incorporate advanced information technology to support the educational process.

J. TENNESSEE VALLEY AUTHORITY

The Tennessee Valley Authority (TVA) Education and Skills Development Department, along with the Tennessee State Department of Education, established a five-county computerized learning network to enhance basic skills and adult literacy education. Each network consists of "learning labs" established in schools, businesses, and human service agencies, linked by phone lines to a host computer. The program utilizes a computer-based educational assessment and instructional system that diagnoses, prescribes and presents instruction on a comprehensive primary curriculum. This curriculum will support the educational process for all students, but is aimed primarily at the educational development of at-risk students, illiterate adults, and persons lacking basic skills.

K. PUBLIC SECTOR

The public sector has numerous pilot programs, grant sponsored programs, and demonstration projects underway in the field of education. Almost every state has sponsored activity in this area. In some instances these activities date back to the late 1960s, but most activities originated within the past five years. Funding for these educational initiatives come from a variety of sponsors, such as the U.S. Department of Education, state departments of education, state legislatures, federal grants, state universities, and private corporations.

Although numerous educational initiatives are underway throughout the U.S. school systems, few of these initiatives are actually capitalizing on the use of advanced information technology. Most of these projects rely on the use of telephones, facsimile machines, one-way communications, and outdated and unsupported automation tools. Several factors contribute to this dilemma: a lack of consistent funding, a need for more telecommunications specialists and telecommunications consultants for the schools involved, a lack of facilitator training, and a lack of comprehensive information on the selection of technology components for these projects. A few of the state initiatives are described below.

The Iowa Communications Network (ICN) currently includes over 2,600 miles of fiber-optic cable that links together 15 regional centers, 3 regent universities, and Iowa Public Television. The ICN currently provides 63 college courses via distance learning. Also workshops and seminars for educators and town meetings are conducted over the ICN. It is the goal of the State Administration to ultimately link up every college and high school via the ICN.

In Alaska, the State Department of Education has developed a network of computers and audio equipment that permits computer screen images and sound to be transmitted over standard long-distance telephone circuits. The network permits instructors to interact with many students located at various remote sites, and enables students to interact with each other in a multipoint-to-multipoint configuration. The network supports interactive communication among all connected sites. Courses are taught from a central hub in Kotzebue or from campuses at Fairbanks, Anchorage, or Juneau.

In Ohio, a number of local and statewide organizations are working to increase access to networks for educational use. These include the State of Ohio Network for Integrated Communications, which provides connectivity for all state agencies; the Ohio Educational Computer Network, charged with developing K-12 educational links; Cleveland FreeNet, a regional network; and the Ohio Academic Resources Network, which links colleges and universities.

The County of Anne Arundel, Maryland, in collaboration with three cable companies in the county, has established studios in 12 high schools for the delivery of two-way video and two-way audio broadcasts. A projection screen in the classroom provides a large image for the receiving class, and facsimile machines permit the transmission of information between locations. Each location has a classroom dedicated to interactive cable television, allowing the master teachers to teach from their schools. This system allows teachers to instruct from their homes and enables students who are at home to watch their classes on cable television.

The Global Schoolhouse (GSH), a project being developed and implemented through the California Regional Education Network (CalREN), is a nationally recognized K–12 pilot project that uses information technology to join classrooms and teachers around the state and around the country. Teachers work with technology experts to

develop specialized curricula using the powerful learning tools available through computer software and networking technology. Students collaborate to investigate global scientific issues using the tools and curricular materials. This project will enable significant information access to urban and rural disadvantaged and minority students of all ages

The Public Broadcasting Service (PBS) offers a distance learning program, "Going the Distance," which has signed up 49 colleges to participate in a nationwide effort to coordinate adult telecourse offerings. The colleges will list their courses in a PBS catalogue and assign faculty to be responsible for answering students' questions and grading assignments.

IV. BARRIERS TO IMPLEMENTING DISTANCE LEARNING

A. SECURITY

The absence of security management and user authentication are two of the most challenging issues related to distributed networks and to applications running on these networks. Security management ensures that no one can tamper with, or intercept information transmitted through, the network. User authentication verifies the identities of parties on both sides of an electronic transaction. Customers, or users, on distributed networks are reluctant to exchange sensitive information.

The NII will need to accommodate adequate security systems to protect privacy, the confidentiality of sensitive information, and intellectual property rights. The network must also accommodate varying levels of access to resources in education and training settings.

B. CORPORATE CULTURE

While many institutions and businesses have been forced to make advances to regain or maintain their competitiveness, schools' instructional methods have not changed appreciably over the years. School officials still are not convinced that traditional teaching techniques will be enhanced through advanced information technology tools, and they are therefore reluctant to make the enormous investments necessary to obtain them.

Fear of change, reluctance to collaborate, and unwillingness to use new applications and systems regularly also hinder improvements of the educational process. To realize the full benefits of new applications and the NII, users must be willing to change their work habits and life styles, and organizations must be willing to change their traditional ways of doing business.

C. TECHNICAL SUPPORT

Frequent technical problems encountered when using computer technology are a source of irritation, frustration, and discouragement for users. For teachers and students who have limited skills, these inconveniences may mean the difference between no

change and quick adoption. Lack of responsive technical support is a real detriment to employing information technology in any forum. A help desk set up for network users will serve to minimize this issue.

D. COST

Incorporating telecommunications networks and new applications into schools requires a large initial capital investment. Schools must be completely rewired to provide classrooms with modem lines, a basic requirement for using the NII. In addition, they have to purchase and install new computer hardware, multimedia devices, and software systems. For most schools, this type of investment is impossible within their current budgets.

School administrators are particularly concerned about the day-to-day expense of using on-line information services. The current telephone line charges for using these services can be prohibitive for schools. Additionally, since overall cost is based on use, and since use varies per person, it is difficult to know in advance how much to budget and whether funding will be sustained.

In the workplace the application of information technology to training is more extensive and technologically advanced than in educational environments, yet it lags well behind what is needed and available. Small firms, those with 100 employees or less, provide about 35 percent of total U.S. employment. These firms lack the expertise to provide in-house training. They also lack the volume of people needing training at one time to justify the cost of contracting-out for training. Larger firms are more likely to provide training than smaller ones, but the training they provide is mostly limited to highly skilled technicians and managers. The lower the level of skills possessed, the less likely the worker is to receive training from any source.[1]

E. PERFORMANCE ASSESSMENT

When organizations conduct economic performance assessments to determine the viability of investing in NII applications, they often fail to understand or even consider the potential long-term advantages. The costs of designing and implementing a new information management system are usually fixed and easy to determine at the outset. The benefits, however, often accrue based on how much an organization uses the

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1 *Breaking the Barriers to the National Information Infrastructure,* a conference report by the Council on Competitiveness, December 1994.

application, and how much it integrates those applications with new ways of doing work. Difficulty in measuring the benefits against the costs of new applications makes the initial investment harder to justify.

Organizations conducting an economic analysis of NII applications should consider more than monetary savings. Improved information management, service to the customer, and employee efficiency are other spillover benefits, though difficult to measure. Excessive concern with immediate cost savings or short-term marginal efficiency gains may cripple an organization's potential for long-term benefits, causing it to decide not to implement information technology applications.

F. EQUITABLE AND UBIQUITOUS ACCESS

Computer technology is unevenly distributed in our schools today when measured by computer density, the ratio of computers to students. Those schools in the top quintile have nine times as many computers as those schools in the bottom quintile. Video technologies such as distance learning equipment, VCRs, and cable TV are more evenly distributed. Schools in rural and poor areas actually have higher densities of these types of equipment. For instance, every school in West Virginia, regardless of its location, has a satellite receive-only dish that provides ready access to televised courses.

A disparity in technology investments also exists between large businesses and small firms which can make only limited investments in training, with or without NII support. In particular, entry level training to facilitate school-to-work transitions remains at the bottom of priority lists. Some of the entry level training needs are being met by electronic home learning. Nonetheless, the situated apprenticeship and basic skills training that could be provided through the NII remain to be developed.

G. AVAILABILITY OF APPLICATIONS

All the capabilities of computer-based instruction and multimedia instruction can be distributed through the NII to schools, workplaces, kiosks, homes, libraries, museums, community centers, and other locations. Yet the infrastructure and applications to support this level of accessibility for education, remote training, and lifelong learning uses have yet to be developed. Until market driven applications are available, education will not realize the full potential of the NII.

H. DIFFICULTY OF USE

Difficulty of use and lack of interoperability frustrate users as they adopt new applications. Application developers must work with users up front to design applications that are specific to users' needs, easy to adopt, and usable with minimal training. Implementation must be as simple as possible so that the changes and new skills required to use the application are perceived to be trivial.

We cite the case of the Val Verde School District in Southern California as an example of what may result when ease of use and interoperability are not taken into consideration when implementing an application.[2] A school reform plan included placing high performance, multitasking, Unix-based computers on every teacher's desk and additional computers in classrooms for student use. Val Verde discarded its existing system and replaced it with new computers. Unfortunately, the new system was unfamiliar to the teachers and students and was not considered user friendly. As a result of this premature scrapping, teachers and students struggled with steep learning curves, and the school system experienced higher than expected training expenses.

I. REGULATIONS AND STATUTES

Two promising NII applications are customizing educational materials and conducting university classes in one part of the country while students watch and respond via two-way video in another. Both are running into legal and regulatory hurdles.

Uncertainty surrounding the use of intellectual property is a common dilemma caused by unclear guidance on how copyright law applies to the use of electronically transmitted materials. There are also differing state education requirements and uncertainty over who has authority. Generally the authority to regulate education belongs to the states, but in distance learning programs can be delivered electronically across state lines. As things now stand, 50 state jurisdictions, each with its own standards and requirements, can seek to regulate distance learning programs.

It is not clear whether state laws should apply to distance learning, or whether transmitting education across state lines constitutes interstate commerce, potentially making it subject to federal jurisdiction instead of state jurisdiction. Outmoded intellectual property laws and differing state education requirements must be altered for the NII to move forward in the area of distance learning.

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2 *Breaking the Barriers to the NII, op. cit.*

V. SUMMARY

All the capabilities of computer-based instruction and multimedia instruction can be distributed to schools, workplaces, homes, libraries, museums, and community centers through NII facilities. Yet the infrastructure and applications to support this level of accessibility for education, training, and lifelong learning uses have yet to be fully developed and implemented. Numerous organizations and agencies are expending considerable effort to develop proper strategies, to develop solutions to barriers impeding progress, and to establish collaborative efforts that will expedite development of the NII.

The barriers, in particular, hamper and limit the development of critical information infrastructure applications by the private sector, the prime builder of the NII. All parties involved—government, private, and public—must work together to overcome the barriers that are impeding the full development and implementation of the National Information Infrastructure.

The government needs to develop policies on security, intellectual property rights, and privacy, and the private sector needs to develop applications that support these policies. In addition the private sector needs to develop distance learning tools and open systems that provide interoperable and secure applications.

At the same time the Department of Defense should develop strategies and perform systems assessments to determine the best solution for implementing distance learning activities throughout the Department. Obviously, the issue is not whether the Department of Defense should adopt distance learning, since it has already implemented portions of the distance learning applications. The issue is how the DoD and the DISA will develop and implement a distance learning architecture.

The Institute for Defense Analyses, as an independent third party, can assist the federal government and the Department of Defense in realizing the full potential of advanced information technology to support distance learning. IDA has the expertise to perform economic benefits analyses of alternative solutions for implementing distance learning applications and assessments of required regulatory and statutory changes to support the full implementation of distance learning.

A critical step in the successful implementation of the distance learning initiative is to identifiy existing or potential barriers that hinder ubiquitous capability. Once the barriers are identified, organizations need to be assigned primary responsibility for overseeing the resolution of relevant issues and implementation of solutions.

With the multitude of organizations involved with the National Information Infrastructure and with the distance learning initiative, the steps outlined above will not be a simple process to accomplish. IDA, as an independent third party, could assist these organizations in identifying barriers to implenting distance learning applications and in developing solutions to removing those barriers based on analytical studies.

APPENDIX A

CHRONOLOGY OF KEY EVENTS

Appendix A
CHRONOLOGY OF KEY EVENTS

February 22, 1993	The Clinton administration issues a report entitled *Technology for America's Economic Growth,* which states that the development of a National Information Infrastructure is a top administration priority.
March 3, 1993	President Clinton announces a 6-month review of the federal government to be led by Vice President Gore. This becomes known as the National Performance Review.
September 1993	The White House through the Office of Science and Technology Policy establishes the National Information Infrastructure Task Force (IITF). The IITF is to articulate and implement the Administration's vision for the NII.
September 1993	The National Information Infrastructure Testbed (NIIT), an industry led consortium, is formed. The mission of the NIIT is to create new jobs, new business opportunities, and spur the growth of a new information infrastructure industry, by accelerating the development of high performance computing and communications technology.
September 7, 1993	The Report of the National Performance Review, *From Red Tape to Results: Creating a Government that Works Better & Costs Less,* is released.
September 15, 1993	President Clinton issues Executive Order 12864 to establish within the Commerce Department the United States Advisory Council on the National Information Infrastructure. The Council shall advise the Secretary on matters related to the development of the NII.
September 15, 1993	The IITF report, *The National Information Infrastructure: Agenda for Action,* is released.
January 1994	The IITF report, *What it Takes to Make it Happen: Key Issues for Applications of the National Information Infrastructure,* is released.
May 1994	The IITF report *Putting the Information Infrastructure to Work* is released.
December 1994	A Council On Competitiveness conference report, *Breaking the Barriers to the National Information Infrastructure,* is released.
March 1995	NIIAC report, *Common Ground: Fundamental Principles for the National Information Infrastructure,* is released.

APPENDIX B

SELECTED BIBLIOGRAPHY

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Breaking The Barriers To The National Information Infrastructure, a Conference Report by the Council On Competitiveness, December 1994.

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APPENDIX C

LIST OF ACRONYMS

Appendix C
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ARPA	Advanced Research Projects Agency
ATD	Advanced Technology Demonstration
CalREN	California Regional Education Network
CD-ROM	Compact Disc Read Only Memory
CISE	Computer and Information Science and Engineering Directorate of DoED
COTS	Commercial off-the-shelf
CoVis	Collaborative Visualization, a program sponsored by NSF
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DISN	Defense Information Systems Network
DIS	Distributive Interactive Simulation
DoC	Department of Commerce
DoD	Department of Defense
DoE	Department of Energy
DoED	Department of Education
EHR	Education and Human Resources Directorate of the DoED
ERIC	Educational Resources Information Center
GSH	Global Schoolhouse, a program under CalREN
HPCC	High Performance Computing and Communications
ICN	Iowa Communications Network
IITF	Information Infrastructure Task Force
Mbps	Mega Bits Per Second

NASA	National Aeronautical and Space Administration
NES	National Education Supercomputer
NII	National Information Infrastructure
NIST	National Institute of Standards and Technology
NPR	National Performance Review
NSF	National Science Foundation
PBS	Public Broadcasting Service
R&D	Research and Development
TVA	Tennessee Valley Authority
UC	University of California

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13. ABSTRACT ***(Maximum 200 words)***

This study of the National Information Infrastructure (NII) was conducted as part of IDA's Central Research Program. Education, to include distance learning, is one of seven key initiatives that the Clinton administration's National Performance Review (NPR) found could be impacted through the implementation of advanced information technology. Distance Learning is a general term used to cover the broad range of teaching and learning events in which the student is separated from the instructor, or other students, by distance and/or time. It includes such scenarios as computers in the classroom or work place, local area networks on a college campus, remote training, and access to educational opportunities from the home. Numerous agencies within the government, private, and public sectors are committed to improving the overall educational process in this country through the implementation of advanced information technology. The objective of this paper is to enhance IDA's understanding of the activities, organizations, and issues related to the application of distance learning, as part of the NII.

14. SUBJECT TERMS
distance learning, education, information technology, lifelong learning, National Information Infrastructure,NII, National Performance Review, NPR, remote training

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